Characteristics of Police-reported Road Traffic Crashes in Ethiopia over a Six Year Period

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Abstract

Ethiopia has one of Africa's fastest growing non-oil producing economies and an increasing level of motorisation (AfDB, OECD, UNDP, & UNECA, 2012). This rapidly increasing mobility has created some unique road safety concerns; however there is scant published information and related commentary (United Nations Economic Commission for Africa, 2009). The objective of this paper is to quantify police-reported traffic crashes in Ethiopia and characterise the existing state of road safety. Six years (July 2005 - June 2011) of police-reported crash data were analysed, consisting of 12,140 fatal and 29,454 injury crashes on the country's road network. The 12,140 fatal crashes involved 1,070 drivers, 5,702 passengers, and 7,770 pedestrians, totalling 14,542 fatalities, an average of 1.2 road user fatalities per crash. An important and glaring trend that emerges is that more than half of the fatalities in Ethiopia involve pedestrians. The majority of the crashes occur during daytime hours, involve males, and involve persons in the 18-50 age group—Ethiopia's active workforce. Crashes frequently occur in mid blocks or roadways. The predominant collision between motor vehicles and pedestrians was a rollover on a road tangent section. Failing to observe the priority of pedestrians and speeding were the major causes of crashes attributed by police. Trucks and minibus taxis were involved in the majority of crashes, while automobiles (small vehicles) were less involved in crashes relative to other vehicle types, partially because small vehicles tend to be driven fewer kilometres per annum. These data illustrate and justify a high priority to identify and implement effective programs, policies, and countermeasures focused on reducing pedestrian crashes.

Introduction

This paper represents the first comprehensive analysis of road traffic crashes in Ethiopia using police-reported crash data. Road traffic crashes pose a significant burden in Ethiopia, as is the case for other developing countries. Currently, developing countries contribute to over 90% of the world's road traffic fatalities (WHO, 2009) and overall road injury disability-adjusted life year (DALYs) increased by 2.5% between 1990 and 2010, with pedestrian injury DALYs increasing by 12.9%, more than any other category (Murray, Lozano, Naghavi, & et al, 2012). This finding implies that a pedestrian injury on the road is a problem that has increased at a global level and is disproportionately attributable to developing countries. The social and economic impacts of road crashes in developing countries are not well understood. It is believed that the implications are immense and that road safety issues require more immediate attention of researchers, professionals, and politicians. Developing countries have embarked on achieving the United Nations Millennium Development Goals as a primary objective; however, the Goals do not explicitly include road safety. Despite the lack of a specific mention of road safety within economic targets, road crashes and economic productivity are linked because primary income earners within families are disproportionately represented among fatalities. At least one study has demonstrated that road crashes have a negative impact on the achievement of the Millennium

Development Goals (Ericson & Kim, 2011). Therefore, the road crash problem in Ethiopia merits investigation both in its own right and because of its linkages with other development objectives.

Recently, Ethiopia has become one of the fastest growing non-oil producing economies in the world (AfDB, et al., 2012). Car ownership has grown rapidly at about 7.0% per annum on average (Ethiopian Roads Authority, 2011). The construction of roads is one of the major focal areas of the government to fast-track economic growth. Although the vehicle population growth rate per annum is increasing, the number of total vehicles remains low compared to other developing countries. Currently road density and number of vehicles per 1,000 population in Ethiopia are low compared with other African countries (Table 1).

The aim of this paper is to quantify, characterise, and interpret trends in road crashes reported to police over a six-year period in Ethiopia. The characteristics considered in the paper include where crashes occurred, when crashes occurred, who was involved, what events or conditions were present, and circumstances contributing to the crashes. The analysis will provide valuable information to policy makers to assist them in curbing the current road crash situation in Ethiopia.

Table 1: Paved Road Density per 1000 sq. km and Vehicle Population per 1,000 People in Selected African Countries The World Bank, 2012; Yepes, Pierce, & Foster, 2009)

	Ethiopia	Uganda	Kenya	Ghana	Nigeria	Botswana	South Africa
Road density by area, km/1,000km^2 in 2001	4	8	13	58	65	10	60
Motor vehicles (per 1,000 people) in 2009	4	8	23	30	31	133	162

Methods

Road traffic crash data were supplied by the Ethiopian Police Commission for the period July 2005 to June 2011 (six years), which was the latest data available at the time. A crash record book is kept at each police stations and each police station reports summarised crash data to the regional state administration (administratively Ethiopia is comprised of nine states and two cities). Regional administrations consolidate the regional reports and submit them to the Federal Police Commission. The crash database variables include time of day, day of week, education, age and gender of drivers, driving experience, driver's relationship with vehicle (employee/owner/other), vehicle service years, vehicle type, vehicle ownership, road type, land use, median and junction types, terrain, pavement type, pavement conditions, illumination, weather conditions, casualty type, and reason for the crash. Vehicle population data were also obtained from the Ethiopian Transport Authority on the numbers of vehicles in different categories. Data from the population census, which was conducted in 2007, was obtained from the Ethiopian Statistics Agency. Then, road crashes were characterised using descriptive analysis to examine the relationships among factors and to identify possible causes and contributing factors. An analysis of time variation of crashes was carried out to identify the most crash-prone hours of the day in order to propose enforcement measures to address the situation. Demographic factors of road users were characterised, as well as road environment factors, crashes by collision and vehicle types.

Results

Variation in Crashes by Time of Day and Day of Week

The majority of crashes occurred during daylight hours. Figure 1 shows that crashes increased rapidly from 6:00am to 7:00am. Numbers were more or less steady until 8:00 pm after which they declined in most cases, though not as steeply as the morning increase. Figure 2 provides traffic volume data by hour for several important roads. It can be seen that the change in volume by time of day is similar to the change in crashes. A study conducted in Nairobi revealed a similar pattern and found that daytime crashes accounted for 83.7% of crashes (Saidi & Kahoro, 2001). There is no information available on the activities being pursued across the day, however it can be speculated that the variation in volume reflects some standard activity patterns with which the first author is familiar. In the morning, most trips are from home to work and/or school. These need to be achieved in a compressed period of time. However, the afternoon rush hours are characterised by trips from work or school to home or other secondary destinations, which take place over a longer period, such that (similar to the change in crashes) volume drops slowly. It should be noted that there was some variability between years, however there was no consistent pattern.

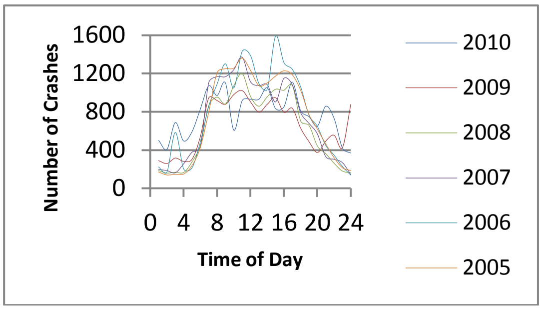

Figure 1: Variation in Road Traffic Crashes by Time of Day, July 2005-June 2011

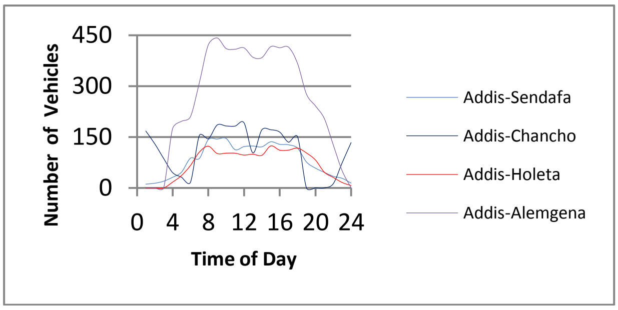

Figure 2: Motorised Traffic Volume by Time of Day on Selected Major Road Segments in 2011 (Ethiopian Roads Authority, 2012).

Crashes by Road User

The age range of drivers involved in crashes is shown in Table 2. The highest number of crashes (fatal, injury, and property damage) involved drivers in the 18–30 year age group (45%) and in the 31-50 year age group (35%). The drivers in the age group 18-30 were involved in more crashes, followed by the age group 31-50 (Misganaw & Gebre-Yohannes, 2011).

Driver education levels were also recorded. Drivers whose education level was junior school or below represented 58.5% and 52.6% of fatally and injury crashes, respectively. This finding is consistent with previous studies in Ethiopia (Misganaw & Gebre-Yohannes, 2011), however it is difficult to reach conclusions about the significance of the findings without knowing the education levels of drivers in the general population.

Gender also presents differentiation in crash involvement. Over the six years, male and female drivers were involved in 10,928 (90.02%) and 684 (5.63%) fatal crashes respectively. Gender in the remaining 528 (4.35%) fatal crashes was not recorded in the crash reports. There are two possible reasons for the high proportion of male drivers involved in crashes. Firstly, professional driving jobs are dominated by male drivers, especially for jobs in remote areas or those that involve nighttime driving. It is worth noting that female involvement in paid employment (or self-employment) is low in Ethiopia (Quisumbing & Yohannes, 2004).

Kilometres travelled per annum by women as drivers are most probably lower than men. Unfortunately there is insufficient information on the gender split between drivers to enable rates to be calculated.

Fatal and injury crashes totalled 66,115 over a six year period. The composition of fatalities and injuries was 22% and 78% respectively. Fatalities in terms of road users (drivers, passengers, and pedestrians) were 7.36%, 39.21%, and 53.43% respectively. In terms of gender, males accounted for 76.98% and females for 22.02% of the fatalities during the period. The population census in 2007 indicated that the split of males and females in the population was almost equal, so that male road users were greatly overrepresented in road fatalities per capita compared with females. As noted above, males are considered to be more likely than females to drive, although data on kilometres travelled by gender was not available, nor is activity based information available. Table 3 shows the fatal crashes according to male and female road users. The trends for male and female road users in various age categories are different. As mentioned previously, males were more vulnerable to death from crashes and roughly 15 times as many male drivers are killed compared with females. The difference is not as marked among passenger and pedestrian fatalities, where male deaths are approximately three times higher than female deaths. Among age groups, those aged under 18 account for only 21.6% of fatalities although they make up more than half the population, such that the 18-30 and 31-50 age groups account for two-thirds of fatalities. This is consistent with international reports that indicate that road traffic injuries are the second and third leading causes of death for age groups 15-29 and 30-44 (WHO, 2000).

Table 2: Crashes by Driver Age, Education, and Gender, July 2005-June 2011

Driver Age	**Fatal**	**Injury**	**Property**	**Total**	**%**
Less than 18	342	775	766	1,883	1.8
18-30	6,005	14,182	25,624	45,811	44.5
31—50	3,853	9,027	23,491	36,371	35.3
More than 51	764	2,023	6,276	9,063	8.8
Unclassified age	1,176	3,447	5,279	9,902	9.6
Total	**12,140**	**29,454**	**61,436**	**10,3030**	**100.0**
Driver Education Level					
Illiterate	374	607	526	1,507	1.46
Writing & reading	598	1,192	1,641	3,431	3.33
Elementary school	2,644	5,327	8,762	16,733	16.24
Junior high school	3,484	8,374	12,838	24696	23.97
High school	3,235	8,638	23,612	35,485	34.44
Above high school	1,077	2,588	9,844	13,509	13.11
Unknown	728	2,728	4,213	7,669	7.44
Total	**12,140**	**29,454**	**61,436**	**103,030**	**100.00**
Driver Gender					
Male	10,928	25,628	54,005	90,561	87.90
Female	684	1,462	3,534	5,680	5.51
Unclassified	528	2,364	3,897	6,789	6.59
Total	**12,140**	**29,454**	**61,436**	**103,030**	**100.00**

Table 3 also presents data on the average annual fatalities rate per 100, 000 inhabitants in these age group categories. Notably, even though these rates illustrate the gender and age group differences described above, they are not high compared with many other countries,

Table 3: Fatalities for Road Users by Gender and Age Group and Population Demography in Ethiopia, July 2005-June 2011 (Population Census Commission, 2008).

Age in years	Fatalities for Road Users in Gender and Age Groups										Population in 2007 (Thousands)				Average Annual Fatality Rate per 100,000 Inhabitants		
	Drivers		Pedestrians		Passengers		Total				M	F	Total	%	M	F	Total
	M	F	M	F	M	F	M	F	Total	%							
<18	45	6	1,562	723	513	271	2,120	1,000	3,120	21.4	19,726	18,742	38,468	52.1	2	1	1
18-30	506	28	1,773	470	2,262	612	4,541	1,110	5,651	38.9	8,658	9,426	18,084	24.5	9	2	5
31-50	355	29	1,565	418	1,274	308	3,194	755	3,949	27.2	5,983	6,005	11,988	16.2	9	2	6
≥ 51	96	5	948	311	295	167	1,339	483	1,822	12.5	2,918	2,439	5,358	7.3	8	3	6
Total	1,002	68	5,848	1,922	4,344	1,358	11,194	3,348	14,542	100	37,285	36,612	73,897	100	5	2	3

Table 4: Road Traffic Fatality Crashes by Road Type and Road Pavement July 2005-June 2011

Road Traffic Fatality Crashes by Road Type							**Total**	**%**
Road Type	**Twelve Month Periods (July-June)**							
	2005/6	**2006/7**	**2007/8**	**2008/9**	**2009/10**	**2010/11**		
Interstate	728	758	768	606	473	1027	4360	35.9
Collector	211	237	238	300	375	509	1870	15.4
Access	237	327	351	224	360	215	1714	14.1
City	625	707	690	672	1003	499	4196	34.6
Total	1801	2029	2047	1802	2211	2250	12140	100
Road Traffic Fatality Crashes by Road Pavement (Surface) Type								
Asphalt roads	1237	1429	1208	1242	1534	1494	8144	67.1
Asphalt roads with some distress	76	65	66	75	221	354	857	7.1
Gravel roads	379	416	471	314	356	397	2333	19.2
Earth roads	109	119	302	171	100	5	806	6.6
Total	1801	2029	2047	1802	2211	2250	12140	100

but the overall rate of 3 road traffic deaths per 100,000 population is also considerably lower than the rate of 18 estimated by the latest Global Status Report on Road Safety (WHO, 2013). This sixfold discrepancy may be due to significant underreporting of crashes, and this requires further investigation.

Crashes by Road Environment

Table 4 indicates that interstate and city roads accounted for 70.5% of fatal crashes. Most of these are paved two-way two-lane roads. A pilot speed study conducted in an urban environment on paved roads in the southeast of the country indicated that 47% of 1,307 vehicles observed disobeyed the posted speed (National Road Safety Coordination Office, 2006). According to the practice in Ethiopia, the posted speed is 30 kph in towns since the roadways are often used by mixed traffic, especially pedestrians and animal drawn carts. Observations at some sites indicate that there are many inconsistencies in design speed as well as posted speed (Mekonnen, 2007), and passing lanes are rarely provided.

Although only 16.1% of the population live in urban areas, these areas account for the majority of road traffic crashes due to the clustering of vehicles in cities, for instance vehicles in Addis Ababa constitute 77% of country's vehicle population (Akloweg, et al., 2011; Population Census Commission, 2008). This implies that road traffic crashes typically occurred in busy areas. About 74.4% of fatal crashes occurred on paved roads and only 25.2% on gravel and earth roads, whereas paved roads make up only 18.62% of the road network, while 28.31% are gravel, and 53.07% earth (Ethiopian Roads Authority, 2011). Paved roads are heavily trafficked in terms of loads and volumes, mainly because the provision of asphalt paved surfaces depends on the volume of traffic. Unfortunately, actual traffic volumes are not known and so rates cannot be calculated to enable comparison between road surface types.

There are also links between different land use types and the occurrence of crashes. The analysis indicates that most fatal and injury crashes occurred in and around cities, particularly in central business districts and residential areas. Table 5 shows that 27.7% fatalities and 33.4% of serious injuries occurred in central business districts and residential areas in the six year period under consideration. This is consistent with the findings of another study which was carried out in Addis Ababa (Misganaw & Gebre-Yohannes, 2011). Similarly, 39.1% of property damage crashes occurred in central business districts. The high occurrence of crashes in these areas may be explained by the complexity of the road environment, mixed traffic and built-up property along these roads that attracts mixed road users with variation across time and location. Rural villages are also crash prone areas, second to central business districts and residential areas for fatalities. The speed limit in village sections in Ethiopia is 30kph; however, most drivers operate on these road environments at a higher speed as they approach from open and agricultural areas, and then do not reduce their speed sufficiently (National Road Safety Coordination Office, 2006). A probable contributor to this behaviour is the lack of provision of transitional speed zones. For instance, the speed limit on paved, rural, two-lane roads is 80kph, but villages and towns along the roads have a speed limit of 30 kph without any transitional speed zones in between. As a result of the lack of transition, geometric parameters and roadside features can change abruptly and motorists may encounter heavy workload (e.g. pedestrian and animal traffic) which creates safety risks (Fitzpatrick et al., 1999).

Table 5: Crashes by Land Use

Land use	Fatal Crashes	%	Injury Crashes	%	Property Damage	%
Rural village areas	3041	25.0	4737	16.0	4334	7.1
Agriculture areas	1948	16.1	3584	12.1	4360	7.1
School areas	892	7.4	1903	6.5	2379	3.9
Industrial	355	2.9	929	3.2	1554	2.5
Church areas	462	3.8	1369	4.7	2855	4.7
Market areas	820	6.8	3147	10.8	6720	10.9
Recreational areas	562	4.6	1908	6.4	4505	7.3
Hospital areas	342	2.8	617	2.1	2552	4.2
CBD	1765	14.5	6290	21.4	24039	39.1
Urban Residential	1597	13.2	4234	14.3	6955	11.3
Other	356	2.9	736	2.5	1183	1.9
Total	12140	100	29454	100	61436	100

Table 6: Fatal and Injury Crashes in the Six Year Period by Lanes/Medians, Road Alignment, Junction Type and Illumination Conditions

	Fatal Crashes	%	Injury crashes	%
Lanes/Medians				
One way	3020	24.88	6391	21.7
Undivided Two way	7278	59.95	16631	56.46
Double carriageway (median)	1482	12.21	5335	18.11
Two-way (divided with solid lines road marking)	236	1.94	727	2.47
Two-way (divided with broken lines road marking)	124	1.02	259	0.88
Total	**12140**	**100.00**	**29454**	**100**
Road Alignment				
Tangent road with flat terrain	7,913	65.18	19832	67.33
Tangent road with mild grade and flat terrain	1,166	9.60	2797	9.50
Tangent road with mountainous terrain and escarpments	348	2.87	816	2.77
Tangent road with rolling terrain	337	2.78	909	3.09
Gentle horizontal curve	587	4.84	1,325	4.50
Sharp reverse curve	525	4.32	1,069	3.63
Steep grade upward with mountainous terrain	515	4.24	990	3.36
Steep grade downward with mountainous terrain	669	5.51	1,478	5.02
Other	80	0.66	238	0.81
Total	**12,140**	**100.00**	**29,454**	**100.00**
Illumination conditions				
Daytime with sufficient daylight	7,581	62.5	20,094	68.22
Twilight	871	7.17	2,004	6.80
Sun rising	874	7.20	1,590	5.40
Night with sufficient light	1,293	10.7	2,470	8.39
Night with insufficient light	542	4.46	1,519	5.16
Night without light	781	6.43	1,407	4.78
Other	198	1.63	370	1.26
Total	**12,140**	**100.00**	**29,454**	**100.00**
Road junction type				
Midblock	8,565	70.55	21,977	74.61
Y-junction	1,570	12.93	2,030	6.89
T-junction	742	6.11	2,367	8.04
Roundabout	371	3.06	848	2.88
Four leg junction	539	4.44	1,600	5.43
Five leg junction	95	0.78	111	0.38
Rail crossing	34	0.28	68	0.23
Other	224	1.85	453	1.54
Total	**12,140**	**100.00**	**29,454**	**100.00**

The absence of median strips or barriers also has a significant effect in increasing crashes. Usually, rural two-lane roads lack these physical barriers which separate opposing the incoming and outgoing traffic flows. Two-way, two-lane roads constitute the major proportion in of the road network in Ethiopia. According to the six years of data considered here, 59.95% of fatal crashes occurred on undivided roadways with two lanes. Dual carriageway and one-way roads accounted for 12.21% of fatal crashes. In the case of injury crashes, the former types accounted for 56.46% of the total injuries and the latter were responsible for 18.11%. The provisions of median barriers are dependent on traffic volume, which means there are few kilometres of such roads, almost all in Addis Ababa.

With respect to road alignment, 65.18% of fatal and 67.33% of injury crashes occurred on tangent (straight) road segments with flat terrain. Tangent roads with mild grade and flat terrain contributed to 9.6% of fatal and 9.5% of injury crashes. Adding these figures together, this means that 74.78% of fatal crashes and 76.83% of injury crashes occurred on tangent roads with almost flat terrain in the period July 2005-June 2011 (Table 6). These findings are in line with other studies conducted in Ethiopia (Misganaw & Gebre-Yohannes, 2011; Tulu, 2007). Crash probability usually increases in mountainous and escarpment terrain road sections (Council, 1998), but without traffic volume data it is difficult to confirm this result in Ethiopia. There is also research evidence that tangent road segments may actually be riskier than horizontal curves on four lanes roads (Hauer, Council, & Mohammedshah, 2004), and again this cannot be confirmed in Ethiopia with current data.

Lighting conditions were important. As mentioned above, most crashes occurred in daytime with sufficient lighting conditions, which is similar to findings in other research (Saidi & Kahoro, 2001). Table 7 shows that 62.45% of fatal crashes and 68.22% of injury crashes occurred in daylight. When twilight and sunrise are included with the daylight category, with the crash proportion rises to 76.82% of fatal and 79.98% of injury crashes. Research elsewhere has found that high rates of pedestrian fatal crashes around twilight and sunrise (Griswold, Fishbain, Washington, & Ragland, 2011); however, it was not possible to check whether this applied in Ethiopia.

Midblock road sections had a considerable share of fatal and non-fatal crashes in the six years, probably because much pedestrian crossing takes place in these sections. Overall, 70.55% of fatalities and 74.61% of non-fatal injury crashes occurred on midblock road sections, as shown in Table 6. By comparison, intersections were safer, which is contrary to the findings usually reported in the research literature (Tay & Rifaat, 2007). Marked and other crossing facilities are rare in midblock areas, which might result in increased fatal and non fatal crashes.

Crashes by Collision Type

Most crashes occurred while vehicles were driving straight ahead on tangent road sections (68.69% of fatal crashes and 71.44% of injury crashes). In contrast, manoeuvring at intersections, overtaking, U-turns, entering and exiting from driveways, and other types of manoeuvre contributed relatively less to the occurrence of fatal and non-fatal crashes.

During the six years, pedestrian collisions comprised 48.55% of fatalities, while rollovers accounted for 17.34%. For injuries, the respective figures were 53.16% and 17.17%. The high rate of pedestrian collisions is common in developing countries and has been attributed to factors including poor land use planning, poor pedestrian behaviour, poor enforcement of traffic regulations, inadequacy of the road network and poor road maintenance, and inadequate provision of pedestrian facilities (Damsere-Derry, Ebel, Mock, Afukaar, & Donkor, 2010; Gwilliam, 2003; Nantulya & Reich, 2006; Shah & Silva, 2010). Moreover, there are many pedestrians, so if a vehicle is going to run into a road user, it in all likelihood be a pedestrian. Rollover crashes often occured on horizontal curved sections of roads, however, most rollover crashes in Ethiopia occurred on tangent road sections. The causes of rollover crashes on tangent sections of roads could include speeding, which has been found to contribute as much as 45% to rollover crashes (Mcknight & Bahouth, 2011).

Not observing priority of pedestrians and speeding were major causes of fatal and non fatal crashes. The two combined contributed to 44.80% and 45.89% of fatal and injury crashes respectively. Observational studies undertaken in Ethiopia indicate that disobeying traffic control devices is a major problem (Tesema, Abraham, & Grosan, 2005). This noncompliant behaviour of drivers also extends to other causes of crashes. Some of those identified in the literature are speeding, failure to give priority to pedestrians, and incorrect overtaking. Moreover young drivers in the age category 18-30, particularly in professional driving are riskier in their behaviour (Misganaw & Gebre-Yohannes, 2011). In contrast, drink driving and drug driving made nonsignificant contributions in terms of fatalities and injuries during this period. The figure might be nonsignificant due to the lack of testing for alcohol and drugs. WHO notes that Ethiopia undertakes little alcohol and drug testing (WHO, 2013).

Table 7: Crashes by Collision and Vehicle Type

Description	Fatal Crashes	%	Injury Crashes	%
Collision Types				
Head –on collisions	**604**	**4.98**	**608.98**	**4.48**
Rear-end collisions	**333**	**2.74**	**335.74**	**4.16**
Broadside collision	**284**	**2.34**	**286.34**	**2.85**
Sideswipe collision	**260**	**2.14**	**262.14**	**2.72**
Rollover	**2105**	**17.34**	**2122.34**	**17.17**
Collision with pedestrians	**5894**	**48.55**	**5942.55**	**53.16**
Fall from vehicles	**1024**	**8.43**	**1032.43**	**6.46**
Collision with animals	**609**	**5.02**	**614.02**	**4.23**
Collision with roadside parked vehicles	**219**	**1.8**	**220.8**	**1.49**
Collision with road side objects	**370**	**3.05**	**373.05**	**1.43**
With Train	**233**	**1.92**	**234.92**	**0.07**
Others	**100**	**0.82**	**100.82**	**0.74**
Unknown	**105**	**0.86**	**105.86**	**1.04**
Total	**12140**	**100**	**12240**	**100**
Type of Vehicles				
Cycle and Motorcycle	451	3.71	1258	4.27
Automobile and Land Cruiser	1204	9.92	5606	19.03
Commercial Vehicle	5780	47.61	11124	37.77
Minibuses and Buses	4191	34.52	10569	35.88
Earth Moving	183	1.51	248	0.84
Rail	2	0.02	5	0.02
Animal Drawn Cart	48	0.40	126	0.43
Others	70	0.58	173	0.59
Unknown	211	1.74	345	1.17
Total	12140	100.00	29454	100.00

Involvement of Vehicle Types in Crashes

Crashes were analysed in terms of vehicle type, and findings indicated that commercial vehicles were involved in 38.4% of fatalities and 37.8% of injuries in the six-year period.

Minibus taxis and buses were also involved in 34.5% of fatalities. However, these trucks and buses currently make up only 18.22% and 12.49% respectively of the vehicle population in the country. This is consistent with other research which has found that trucks were more involved in crashes in less developed countries (Mohan, 2002). On the other hand, automobile vehicles had low fatality and injury records; however, there were significantly high numbers of property damage crashes during the period. This may be due to the lower annual kilometres travelled by this group of vehicles, however there are no data to confirm this. Vehicle roadworthiness may be a problem, since 36% of imported vehicles and 65% of the vehicle population have been found to have an age of over 15 years (Akloweg, et al., 2011). Given these figures, it is not surprising that vehicles aged over 5 years were involved in the majority of crashes in Addis Ababa (Akloweg, et al., 2011).

Discussion

This paper represents a unique and comprehensive descriptive analysis and interpretation of injury crashes on Ethiopian roads. The following major trends and observations are revealed by the comprehensive analysis:

1. The variation in road traffic crashes by time of day reflects variations in traffic volumes, and most crashes occur during daylight. However, the level of severity may not follow the same pattern and needs further in-depth investigation.

2. Driver involvement in crashes disproportionately high for the 18-30 age group, followed by the 31-50 age group. This trend also applies for all road users killed and injured. As a developing country, the population age distribution indicates that about half the population are aged under 18, however people of working age are more likely to be involved in crashes. It is likely that, on average, individuals in the workforce make more trips per day by various modes of transportation, especially as pedestrians. As a result, they spend more time in contact with motorised traffic in a variety of road environments and are therefore more exposed to the risk of crashes. Thus, unlike other age strata, these age groups suffer more injuries and deaths from road traffic crashes.

3. Most crashes occurred on paved two-way two-lane roads (in cities and on interstate highways), particularly in central business districts; and residential areas. As a developing country, the transportation systems in urban areas cater to mixed traffic including high speed vehicles, pedestrians, animals, and animal drawn carts. The speed can vary from 5km/hr to 80km/hr and these speed differentials have been recognised as risk factors for road traffic crashes. Moreover, the complexity of land use, lack of comprehensive transportation planning, and many social activities along or on the roads in urban areas may have contributed to the rise in road traffic crashes. The urban road environment is not conducive to the safety of road users and could be addressed by implementing sound transport planning which in turn minimises activities in and along roads. The separation of non-motorised traffic from roadways could assist in the reduction of road traffic crashes. Inconsistencies of speed zoning could be addressed through the implementation of a road safety audit process during the planning, construction and operation stages of roads.

4. Medians separate traffic flows in opposing directions and can also be used as a recovery area for errant vehicles and a refuge for pedestrians. The absence of medians contributed

to crashes in Ethiopia. In addition, tangent alignment of road sections, and midblock areas were the most common locations of crashes. There is a need for good exposure data (such as traffic volumes) to determine whether these factors are over-represented among crashes. However, factors like speeding may be mitigated by provision of low cost engineering measures. In the case of midblock crossings, advance warning signs and markings for vehicles and pedestrians, and road safety education may be viable solutions.

5. In terms of collision types, pedestrian crashes are the dominant types of collision, as motorised traffic and pedestrians share the same facilities. Failing to observe pedestrian priority and speeding are the likely root causes for the high level of crashes in the country. As suggested previously, the separation of non motorised traffic from highways—through both hard-scape and soft-scape measures--may represent a viable solutions for protecting pedestrians.

6. Ethiopians are more likely to make use of commercial vehicles, minibuses and buses to support mobility needs. Commercial vehicles, minibuses, and buses have a high involvement in crashes, although again there is a need for exposure data to determine whether they are over-represented. It is also highly likely that these vehicles travel more kilometres per annum which contributes to both a high number of crashes and a high rate. Countermeasures might include higher training and licensing standards for professional drivers, adherence to vehicle capacity limits, and other improvements to infrastructure identified previously.

The observed trends in Ethiopian road crashes provide guidance on their current road safety problems and challenges, and point to possible areas of countermeasure development and implementation. In many cases countermeasures, policies, and programs will need to represent low-cost solutions, given economic constraints within the country. In order to conduct a more refined analysis of crashes exposure data will be needed; thus, the collection of exposure data in Ethiopia should become a priority moving forward.

References

AfDB, OECD, UNDP, & UNECA. (2012). *Economic Outlook: Ethiopia*. Retrieved from http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Ethiopia%20Full%20PDF%20Country%20Note.pdf

Akloweg, Y., Hayshi, Y., & Kato, H. (2011). The Effect of Used Cars on African Road Traffic Accidents: a Case Study of Addis Ababa, Ethiopia. *International Journal of Urban Sciences*, *15*(1), 61-69.

Council, F. M. (1998). Safety Benefits of Spiral Transitions on Horizontal Curves on Two-Lane Rural Roads. *TRANSPORTATION RESEARCH RECORD 1635*, 10-17.

Damsere-Derry, J., Ebel, B. E., Mock, C. N., Afukaar, F., & Donkor, P. (2010). Pedestrians' injury patterns in Ghana. *Accident Analysis & Prevention, 42*(4), 1080-1088.

Ericson, M., & Kim, P. (2011). How Road Traffic Injuries Affect Household Welfare in Cambodia Using the Millennium Development Goals Benchmarks. *Asian Studies Review*, *35*(2), 209-234.

Ethiopian Roads Authority. (2011). *Road Sector Development Program (RSDP): 13 Years Performance and Phase IV*.

Fitzpatrick, K., Wooldridge, M. D., Tsimhoni, O., Collins, J. M., Green, P., Bauer, K. M., . . . Poggioli, B. (1999). *Alternative Design Consistency Rating Methods for Two-lane Rural Highways*.

Griswold, J., Fishbain, B., Washington, S., & Ragland, D. R. (2011). Visual assessment of pedestrian crashes. *Accident Analysis and Prevention, 43*(1), 301-306. Gwilliam, K. (2003). Urban transport in developing countries. *Transport Reviews, 23*(2), 197-216.

Hauer, E., Council, F. M., & Mohammedshah, Y. (2004). Safety Models for Urban Four-Lane Undivided Road Segments. *Journal of the Transportation Research Board, 1897*, 96-105.

Mcknight, A. J., & T.Bahouth, G. (2011). Analysis of Large Truck Rollover Crashes. *Traffic Injury Prevention, 10*(5), 421-426.

Mekonnen, H. (2007). *Design Consistency of Horizontal Alignments on Two - Lane Trunk* ... Msc Degree Thesis, Addis Ababa, Ethiopia.

Misganaw, B., & Gebre-Yohannes, E. (2011). Determinants of Traffic Fatalities and Injuries in Addis Ababa. *Journal of the Ethiopian Statistical Association, XX*, 41-.

Mohan, D. (2002). Road Safety in Less-motorised Environments: Future Concers. *International Journal of Epidemology, 31*, 527-532.

Murray, C. J. L., Lozano, T. V. R., Naghavi, M., & et al. (2012). Disability-adjusted Life Years (DALYs) for 291 Diseases and Injuries in 21 Regions, 1990–2010: A Systematic Analysis for the Global Burden of Disease Study 2010. *The Lancet, 380*(December 15/22/29,2012), 2197-2224.

Nantulya, V. M., & Reich, M. R. (2002). The neglected epidemic: road traffic injuries in developing countries. *Education and debate, 324*, 1139-1141.

National Road Safety Coordination Office. (2006). *Overview of the Road Safety Activities in Ethiopia*. Retrieved from

Odero, W., Garner, P., & Zwi, A. (1997). Road Traffic Injuries in Developing Countries: a Comprehensive Review of Epidemiological Studies. *Tropical Medicine and International Health*, 2(5), 445-460.

Population Census Commission. (2008). *Summary and Statistical Report of the 2007 Population and Housing Census*.

Quisumbing, A. R., & Yohannes, Y. (2004). *How Fair is Workfare? Gender, Public Works, and Employment in Rural Ethiopia*.

Saidi, H. S., & Kahoro, P. (2001). Experiance with Road Traffic Accident Victims at the Nairobi Hospital. *East Africa Medical Journal, 78*(8), 441-444.

Shah, M. Z., & Silva, A. N. R. d. (2010). *Pedestrian Infrastructures and Sustainable Mobility in Developing Countries: The Cases of Brazil and Malaysia*. Paper presented at XVI PANAM, Lisbon, Portugal.

Tay, R., & Rifaat, S. M. (2007). Factors Contributing to the Severity of Intersection Crashes. *Journal of Advanced Transportation, 41*(3), 245-265.

Tesema, T. B., Abraham, A., & Grosan, C. (2005). Rule mining and classification of road accidents using adaptive regression tree. *International Journal of Computational Intelligence Research, 6*(10 and 11), 80-94.

The World Bank. (2012). Motor vehicles (per 1,000 people) Retrieved from http://data.worldbank.org/indicator/IS.VEH.NVEH.P3.

Tulu, G. S. (2007). *The cause of road traffic accident and its countermeasure for Addis Ababa-Shashemene road [Msc Thesis]* Msc. Degree in Road and Transportation. Addis ABaba University, Addis Ababa.

United Nations Economic Commission for Africa. (2009). *Case Study: Road Safety in Ethiopia.*

WHO. (2000). *A Leading Cause of the Global Burden of Disease*. Retrieved from

WHO. (2009). *Global status report on road safety: Time for action. Geneva: World Health Organisation*. Retrieved Feb 24, 2011, from www.who.int/violence_injury_prevention/road_safety_status/2009.

WHO. (2013). *Global Status Report on Road Safety 2013 Supporting a Decade of Action*.

Yepes, T., Pierce, J., & Foster, V. (2009). *Making Sense of Africa's Infrastructure Endowment A Benchmarking Approach*.